INFORMATION NOTE ON SCIENTIFIC, TECHNICAL, AND TECHNOLOGICAL MATTERS OF AGRIENVIRONMENT, BIODEFENSE, AND ECOLOGICAL PUBLIC HEALTH

(Protecting Global Health and Promoting Healthy Communities Worldwide)

Convention on the Prohibition of the Development, Production a Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction

2010 Meeting of Experts, United Nations, Geneva

WORKSHOP ON MECHANISMS FOR SCIENTIFIC, TECHNICAL, AND TECHNOLOGICAL MATTERS OF INTERNATIONAL COOPERATION UNDER BTWC

WORKSHOP CHAIR:

Ms. Anupa Gupte (anupagupteahoo.com)

9-10 am, Friday, 27 Aug. 2010, Room XXIII, United Nations, Geneva

TABLE OF CONTENTS

I. Biodefense Preparedness and Response:

Biodefense is most often discussed in the context of biowar or bioterrorism, and is generally considered a military or emergency response in terms of medical countermeasures against chemical, biological, radiological, nuclear, and explosive (CBRNE) threats. Biodefense applies to two distinct target populations: civilian non-combatant and military combatant (troops in the field). For the purpose of this workshop, however, the term 'biodefense' is used only in the context of ecological public health preparedness for prevention and non-proliferation of biological weapons, especially infectious diseases.

In the alleged use of chemical, a hazardous materials (HAZMAT) team and local first responders may have the opportunity to decontaminate a significant number of victims prior to their arrival at the hospital or health are facility.[1] Unlike a chemical attack or event, a biological event may be unannounced due to which the emphasis is not decontamination but rather respiratory isolation of the patient/victim with adherence to established standard precautions until the agent is known.

Therefore, there are several cross-cutting themes that underlie the health sector's response to alleged use or bioattack. Basic concepts and tools of public health and preventive medicine provide a sound basis for addressing global environmental modification which requires public health and preventive medicine to engage and anticipate health needs on an unprecedented time scale in today's world at risk. Attribution still has very serious limitations and attacks are all too possible where there could be no attribution, great ambiguity, a serious risk of deception or "false flags," or insufficient evidence to act with international support.

Much still needs to be done in detection, particularly to create effective and reliable systems capable of any form of characterization without significant false alarms and mistakes. Complementary health care, environmental, and public health data, infrastructure, systems and services should be capable of responding with appropriate ecological public health or medical measures that will minimize illness, casualties, and death. Improvements in surveillance systems are necessary to give adequate warning for providing effective prophylaxis and treatment to affected populations.

The next new high-impact zoonotic pandemic will originate in the Tropics.[2] Therefore, global resources to counter emerging infectious diseases need to be urgently reallocated to tropical States/Parties that are the 'hot spots' for

---

[1] 2008, Liudvikas Jagminas (MD, Associate Professor of Emergency Medicine, Alpert Medical School of Brown University; Physician-in-Chief of Emergency Medicine, Memorial Hospital of Rhode Island, U.S.A.), 'CBRNE - Evaluation of a Biological Warfare Victim', e-medicine from Webmed – Medscape's Continually Updated Clinical References, accessed 17 Aug. 2010, CBRNE - Evaluation of a Biological Warfare Victim: eMedicine Emergency Medicine.

[2] 2008, Kate E. Jones, Nikkita G. Patel, Peter Daszak, *et al*, 'Global trends in emerging infectious diseases', *Nature* 451, 990-993, doi:10.1038/nature06536, http://www.wildlifetrust.org/writable/publications/nature06536.pdf

emerging infectious diseases. At present, global resources are poorly allocated due to which majority of the scientific and surveillance effort is focused on countries from where the next important emerging infectious disease is least likely to originate. Moreover, global zoonotic capacity also exists mainly in developed States/Parties. The greatest potential to save lives rests on the early recognition of the incident, accurate clinical diagnoses, and the expedient mobilization of appropriate hospital, local, and federal resources.

Building capacity is an essential step in preparing for a biodefense response that will require more than financial resources, technology, and public health infrastructure. Human resources and knowledge are critical; institutions that are committed to and support the goals articulated in “Health for All” and Millennium Development Goals (MDG) Target “Safe Water and Sanitation For All by 2015” are essential. The public health personnel are in a key position to help States and Parties face the health challenges associated with suspicious use and bioattack. Although the likelihood of involvement in a bioattack incident is low for any given emergency physician, for example, the consequences of unpreparedness are potentially catastrophic.

Combating social inequalities in health has become a major challenge for health systems around the world. The availability of tools to measure inequalities is a prerequisite to any planning to reduce them.[3] A multidimensional poverty index (MPI) developed this year by United Nations will be a useful tool in further epidemiological investigations and situational analyses. It is important that public health protection is ecosystem-based in order to integrate the use of biodiversity and ecosystem services into an overall biodefense programme; generating social, economic and cultural co-benefits; drawing on traditional knowledge; and contributing to biodiversity conservation.

II. Why Environmental Modification Matters:

Biodefense preparedness requires a forward-looking, strong and unifying vision of health care in the twenty-first century as well as an understanding of the problems posed by global environmental modification that result in emerging, re-emerging and new infectious diseases. Infectious diseases have acquired a new urgency, requiring immediate attention because of their potential for nearly instantaneous pandemics.

Our capabilities to predict the cause of disease can be enhanced by our understanding of the complex interactions of disease with the web of life and the environment. Of 30 million species of plants, animals and microorganisms believed to be living on the Earth today, each plays a part in the global ecosystem. So far, taxonomists have only identified and named approximately 1.7million. About 50 % of our drugs are made from plants. Developing

[3] 2009, Pampalon R., Hamel D., Gamache P., Raymond G., ‘A deprivation index for health planning in Canada’, Chronic Diseases in Canada, Vol. 29, No. 4, 2009, accessed 24 April 2010, available at http://www.phac-aspc.gc.ca/publicat/cdic-mcc/29-4/pdf/CDIC_MCC_Vol29_4_ar_05-eng.pdf

States/Parties face a number of challenges in describing the species of their often understudied habitats. Low number of specialists and lack of taxonomic infrastructure such as collections are common limitations to taxonomic work in these States/Parties.

About 80 per cent of emerging and remerging diseases are zoonotic and more than 70 per cent outbreaks of zoonotic diseases are now of wild animal source. About half of southern Africa's 47 million cattle are already under threat of emerging and reemerging diseases in spite of improvements in regional disease surveillance and management. About 75 per cent of world's population live in countries where consumption levels are outpacing environmental sustainability. For people in countries at war or subject to economic embargos, many goods are scarce, with shortages of food and water being the most crucial. In such times, illegal trade in endangered species flourishes and bush meat consumption increases, thus increasing the threats of infectious disease spread and of emerging and reemerging infectious diseases.

Outbreaks caused by new and emerging pathogens continue to appear and some of the existing pathogens change their characteristics to increase their survivability. Japanese encephalitis, leptospirosis, Nipah virus, Chandipora virus, West Nile virus, and SARS (Severe Acute Respiratory Syndrome) virus are examples of pathogens that have established themselves in their new habitats and their infections are now considered endemic in those ecological regions. In addition to their immediate catastrophe, alleged use can cause the biological toxin or agent is likely to establish endemicity of another epidemic-prone disease in States/Parties where they are released.

Environmental degradation further deepens this threat and exponentially increases the risks of human insecurity and displacement. International and internal conflicts are increasing and the nature and global dynamics of these conflicts is changing. Moreover, BSL-4 labs are proliferating, especially in the USA, and not all labs are subjected to government oversight. Also, natural disasters such as storms and floods are increasing, often leading to disruptions such as power outage. The best defence against increases in infectious disease burden related to environmental modification lies in strengthening existing public health infrastructure. Physicians, as opinion leaders, can also influence public policy related to global environmental modification.

III. Why Protect Ecosystems As Critical ('Green') Infrastructure:

The need for international cooperation in scientific, technical, and technological matters of suspicious use or bioattack is well-understood by the States Parties to the BTWC and is more urgent in today's world that is at increasing risk.[4] With new and emerging technologies as well as rapid advances in biotechnologies, agroterrorism may be perceived to be a particularly desirable option for terrorists

[4] 2006, World Commission on Weapons of Mass Destruction (WCMD), Weapons of Terror, Chapter 4, http://www.wmdcommission.org/files/Weapons_of_Terror.pdf, accessed 30 Nov. 2009.

for several reasons[5]. Even without state support, individuals and terrorist groups will have steadily better access to the equipment and facilities they need at steadily lower cost.

Biological sciences are adding value to a host of ecosystem products and services, producing what some call the “bioeconomy”. Ecosystem (or ‘green’) infrastructure that is critical to sustaining peace and security is most vulnerable to being targeted due to its increasing economic value and degradation by human activities and associated globalization. This is why the accelerating pace in biosciences, biotechnologies, bioproduction and bioeconomy is of concern.

Accessibility to the technology itself and emphasis on direct to consumer marketing are worrying. In the case of nano, this is clearly seen with nanosilver which is being sold to the public as an antibacterial (incorporated into clothing and appliances). This also makes the silver available to those who might use it illegally or inappropriately. Moreover, this large scale use may be linked to emergence of bacteria resistant to clinical antibiotics too. In the case of synthetic biology (e.g. biobricks), there is an open intent to allow do-it-yourself in your own home genetic engineering. This will be a nightmare for regulators and a really useful tool for those who have nefarious intent.

At present, no border control equipment is available to stop intentional transboundary movement of UG99 spores and attempts to develop UG99-resistant wheat strains continue in vain, lacking formal international collaborations/coordination under the BTWC. Global meteorological data indicates that dust storms in Africa could transport airborne pathogens (such as Ug99) as far away as, for example, to Canada.

Use of new-found technologies running ahead of our understanding of their consequences and what it means to protect “wild” or “natural” biological systems. Problems are likely to emerge on large scales, thus requiring working together in agrienvironment and public health (for example, multidisciplinary scientific information sharing and technology transfer matters). Essential restrictions on some activities or materials, especially their transfer or export controls and supply chain could, with advantage, be implemented in integration with other global strategies and multilateral agreements relevant to BTWC.

Genetic basis of ecosystem processes and effects of changes, such as the introduction of transgenic organisms, on entire communities can be better understood within the evolutionary framework by examining the role of genetic interactions at the ecosystem levels because community and ecosystem phenotypes have a genetic basis and are heritable[6]. Plants are genetically modified by using promoters. Functionally, promoters are defined as carcinogens due to their ability to induce neoplasms[7].

---

[5] 2008, Ryan Jeffrey R. and Glarum Jan F., ‘Biosecurity and Bioterrorism: Containing and Preventing Biological Threats’, Elsivier Inc., UK.

[6] 2006, Whitham TG, Bailey JK, *et al*, ‘A framework for community and ecosystem genetics: from genes to ecosystems’, Nature Reviews Genetics: 510-522, Vol. 7, July 2006, Nature Publishing Group, London, U. K.

[7] Amdur MO, Doull J., Klaassen CD, 1996 'Casarett and Doull's Toxicology: The Basic Science of Poisons' (pp 129, 185-188, 131, 141-144, 160, 830), Fourth edition, 1991, Pergamon Press Inc., U. S. A.

Because of globalization of economies, transportation systems, communications, and food supplies among other influences that have globalized health, the threat of a pandemic may be greater and it now extends to other areas of public health, such as chronic diseases. Therefore, we must grapple with and solve more than one public health problem at a time and focus on the interactions and connections among health-related problems.

For example, the Syndemic Prevention Network offers a means to assemble information that provides a systems view of public health involving two or more afflictions that synergistically contribute to the burden of disease in a population. [8] Using a syndemic orientation, it might be possible to better define the conditions under which categorically organized interventions can be effective and the extent to which fragmentation of the public health system might itself be a barrier to the goal of protecting the public's health.

IV. Public Health Knowledge Management:

Today's public health challenges are increasingly difficult, widespread, and interconnected.[9] To ensure that the right information reaches the right destination as quickly as possible, efficient knowledge management that crosses organizational, community, cultural, national, and geographic boundaries is essential. More rapid and widespread transmission of disease and dissemination of unhealthy behaviours or practices can occur due to the increasing interconnectedness of the world, increasing the inherent potential of infectious diseases to cause pandemics.

To better address global public health challenges, we must share information more efficiently and have knowledge management capacity to create the connections between clusters of health-related issues is critical to establishing interventions and policies that account for the relationship and aggregate impact of public health challenges.[7]

Current public health challenges include not only tracking and containing emerging and reemerging infectious diseases but also responding to emergencies and disasters and preventing chronic diseases. Public health is expected to provide more information faster in this information-driven era and to link electronically with partners in public health care sector. The face-to-face interactions are by far the most valued and effective activity for information exchange and knowledge communication.

Communities of practice have been recognized as a potential strategy to harness knowledge of the experienced workforce and shape the practice of public health informatics. Communities of practice can be a valuable approach to organizational learning as public health agencies grapple with new

[8] 2010, Chen Hsinchun, Zeng Daniel, Yan Ping, 'Infectious Disease Informatics: Syndromic Surveillance For Public Health and Biodefense', Springer Science+Business Media LLC, New York, U. S. A.

[9] 2010, Jay Liebowitz, Richard A. Schieber, Joanne D. Andreadis, 'Knowledge Management in Public Health', CRC Press, U. S. A.

partnerships such as of transdisciplinary information exchanges and health challenges such as of chronic disease prevention, bioterrorism, climate change, and emergency preparedness.

V. Key Public Health Knowledge Gaps:

Key public health knowledge gaps are summerized below:

Capacity

- interdisciplinary approaches are required to address the complex problems associated with research on food-, water-, vector- and rodent-borne diseases and environmental modification;
- researchers will need to be trained in interdisciplinary approaches; and
- specialized technical expertise is needed to enhance response capacity.

Enumeration of current disease risks

More detailed quantification is needed of the infectious diseases that are affecting or could affect global populations. The geographic distribution of zoonoses in wildlife and of vectors is poorly understood, which limits the power to predict human populations at risk if effects of climate change on risk were to be identified.

Assessment of surveillance systems

There is a need to assess the adequacy of surveillance systems to detect significant changes in the incidence and geographic distribution of pathogens in humans and in important sentinel non-human species.

Development of warning systems

There is a need to improve the linkage between pathogen surveillance and meteorological information where climate is an indicator for a potential disease event. There is a pressing need to develop a better understanding of the impacts of extreme weather events on public health infrastructure and vulnerability to infectious disease outbreaks in order to develop warning systems. For example, heavy rainfall may contribute to water supply contamination as well as provide breeding areas for mosquitoes.

Research

- the ecology of disease from the environmental source to the human case of the disease, including the ecology of hosts and vectors (this knowledge is required to identify where and how a change in climatic conditions might alter the hazards posed by these diseases);
- understanding the ecology of zoonoses in a wider range of wild animal hosts such as marine mammals and wild ungulates; and
- changing behaviour to reduce vulnerability to food-borne illness, particularly as it relates to cultural, social and societal preferences and food-handling and food processing norms.

VI. Interdisciplinary Methods and Data Integration Needs:

Integration of ecological sciences, conservation biology, systems engineering, and medicine is a new frontier of scientific exploration that provides the next leap for the health sciences. Ecosystem analyses from investments made in biocomplexity are proving insightful for public health science and prediction of risks of infectious diseases. Threads of climate, demography, and global monitoring can now be woven together to deal with the complexity that did not exist previously in societies that were less mobile and were not globalized.

The complex link between clouds, chemistry, and climate requires interpretation from the earth, ocean, and atmospheric scientists, as well as computer scientists, and mathematicians/statisticians. Tracking, treating and preventing infectious diseases are truly global in their scope and require the richness of interdisciplinary research and collaborations. Therefore, public health is no longer the domain of any one bound discipline but a work of epidemiologists, ecologists, climatologists, oceanographers, clinicians and many others.[10]

A new breed of public health surveillance systems has the potential to significantly speed up detection of disease outbreaks.[7] Methods are needed to systematize and incorporate local and traditional knowledge into research approaches. Because change often comes about only when people are faced with the inevitable or after an event has occurred, participatory research can act as an early warning system and trigger change in policies and practices at all levels.

VII. Integrated Assessments:

Changes in the prevalence and spread of infectious diseases are some of the most widely cited potential effects of climate change that are mediated through biogeochemical, ecological, socioeconomical and epidemiological processes that interact with each other and which may themselves be influenced by environmental modification. Few examples of integrated assessment methods are: Biosafety Assessment Tool (BAT), Real-Time Technology Assessment (RTTA), and Constructive Technology Assessment (CTA). However, integration of these methods with biothreat assessment methods, such as CARVAR-Shock developed for food defense and emergency preparedness, should also be considered.

Detecting alleged use or a bioattack event involving pathogens or routes of exposure other than intentional release of certain pathogens in aerosol form will require other approaches. Existing food safety frameworks developed for human pathogens and agricultural pests can be strengthened by also extending them to monitor Living Modified Organisms (LMOs) with pre- and post-market surveillance. This will close the present gaps in transboundary movement of LMOs

[10] 2004, EcoHealth Journal Consortium, Editorial, EcoHealth: 1, 6-7, 2004, doi: 10.1007/s10393-004-0067-9

and their risk assessment and advance informed agreement (AIA) methods such as those under the Cartagena Protocol on Biosafety and/or Codex Alimentarius.

Integrated assessments integrate health and environmental modification indicators, changes in the environment and socioeconomics, and technological changes for seeking improved methods of valuation and aggregation of health effects and other effects of climate change.[11] Such integrated assessments allow identification of potentially important indirect interactions or mechanisms, identification of important research gaps, and a means of integrating targeted research from a variety of disciplines into an enhanced understanding of the whole system. Such understanding is vital to make informed, intelligent public health policy decisions. Applying analytical models may lead to insights into transmission patterns. For example, environmental change may affect zoonoses in three ways:

- increasing the range or abundance of animal reservoirs or insect vectors;
- prolonging transmission cycles; or
- increasing the importation of vectors or animal reservoirs (e.g. by boat or air) to new regions, which may cause the establishment of diseases in those regions.

VIII. Infectious Causes of Chronic Disease:[12]

Infectious diseases are the second leading cause of death worldwide and they kill more children and young adults that any other diseases. They are also the leading cause of disability-adjusted life years (DALYs) or lost years of healthy life and they have a significant public health impact. The consequences of long-term infectious diseases are yet to be fully realized.

Chronic diseases caused by infectious organisms vary widely, and yet, they are connected by the vastness of the economic and personal costs associated with chronic disease and psychological, technical, and medical hurdles that need to be overcome to provide casual linkages between an infectious etiology and a chronic disease. Total economic burden from infectious diseases is probably even larger that suspected because few, if any, cost figures include chronic illnesses suspected of having a link to infectious diseases.

Sequelae are the pathological conditions resulting from a prior disease. They differ, depending upon the infectious agent, and yet, they have some commonalities. Why focus on infectious diseases as etiologies of chronic disease? Unlike many curable chronic medical diseases, diseases caused by infectious etiology may be prevented or cured through medical treatments (such as vaccines or antimicrobials respectively) that are a fraction of the cost of lifetime chronic medical care. Thus, the desire to find an infectious cause for major

[11] 1999, Chan Nathan Y., Ebi Kristie L., Smith Fraser, *et al*, 'An Integrated Assessment Framework for Climate Change and Infectious Diseases', Environmental Health Perspectives, Vo., 107, No. 5.

[12] 2009, edited by Fratamico Pina M., Smith James L., Brogden Kim A., 'Sequelae and Long-Term Consequences of Infectious Diseases', ASM Press Washington D. C., U. S. A.

chronic medical illnesses stems, in part, from the hope of curing or preventing these illnesses.

IX. Environmental Burden of Disease:

The DALY system is advantageous to take into account not only the proportional change in each public health impact, but also the size of the disease burden. Although proportional changes in impacts such as diarrhoea and malnutrition are quite modest (compared to floods for example) they are likely to be extremely important in public health because they relate to such a large burden of disease. The DALY system permits policy makers to directly compare the global burden of different diseases, set priorities, and evaluate the cost-effectiveness of their interventions.

The total estimated environmental burden for the present is small in comparison to other major risk factors for health measured under the same framework. However, in contrast to many risk factors for health, environmental exposure and its associated risks are increasing rather than decreasing over time. Lastly, the estimates should be considered not as a full accounting of health impacts but as a guide to the likely magnitude of some health impacts of global environmental change in the near future.

X. Infectious Diseases from the Natural Environment:

The specific interaction between environmental modification and patterns of infectious disease has only recently been recognised as an important factor. One of the key challenges of modern public health is to identify and quantify the mechanisms of this interaction, in order to develop mechanisms for dealing with emerging health threats and to increase preparedness for action.[13]

The etiology of diseases is particularly rooted in the fundamental ecology of the disease agent, whether human or other species. There is already a widespread change in the phenology of plants and animals, as well as in some species distributions. Now threshold change in ecosystems is beginning to be observed in nature. Disease agents that live free in the environment or have stages outside a warm blooded host are most apt to be favoured by climate warming through increased survivability and shortened generation time.

Therefore, a general understanding of the potential impacts of environmental modification on species and ecosystems is fundamental to understanding potential impacts on epidemiology. At minimum, the natural world will experience an equal amount of warming to that which has already taken place. This suggests a future with nature and ecosystem very much in flux with profound implications for epidemiology. Moreover, there will be complex

[13] 2008, European Centre for Disease Prevention and Control (ECDC), Meeting Report, Workshop on linking environmental and infectious diseases data, Sigtuna, 28–29 May 2008, accessed 28 Feb. 2010, available at Publications - 0805_MER_Linking_environmental_and_infectious_diseases_data.pdf...

interactions due to, for example, the upslope movement of the "mosquito line" in a warming world, and therefore, the mosquito- and malaria-free zone will shrink. So nature is on the move in response to environmental modification. These are relatively minor ripples of change in the biological fabric of the planet. The real question is what may lie ahead.

The problem with water is that its wildlife riches and damage to them exist mostly out of our sight. [14] On land, where all is visible, one could direct attention to an environmental issue even when it is not yet fully understood. But water conceals form and function under a surface of relatively uneventful homogeneity. As with all diseases, the social environment, economic and cultural factors, and healthcare systems play a significant role.

Factors such as land use, forestation or water bodies are of particular relevance when dealing with infectious diseases — mainly because of the reservoir–pathogen–vector–host cycle. The complexity of interactions has led to new approaches in the analysis and development of epidemiological models. Species will need safe haven once they have moved and natural connections in the landscape to facilitate the movement to those areas.[15]

With mean warming of 1-2°C by 2100, some regional changes would be significant enough so that adverse impacts to some of these highly sensitive species and systems would become more severe and increase the risk of irreversible damage or loss, and additional species and systems would begin to be adversely impacted. Warming beyond 2°C would further compound the risks.[16]

XI. Infectious Diseases from the Agrienvironment:

The combination of increasing population and resource consumption, along with waste generation, drives the regional environmental change typically indicated by trends in land use and land cover change.[17] Although the pattern of global change varies from region to region, three characteristic processes occur in relation to land use: urbanization, agricultural intensification (including food production and distribution) and alteration of forest habitat. The three categories of land use – urban, agricultural and natural habitat – represent an ecosystem continuum along a gradient from domestic to natural.

Three ecological trends are associated with these changes: vector and reservoir domestication (or peri-domestication); invasion of domestic habitat by opportunistic wildlife such as some rodents and blood-sucking arthropods (mosquitoes, ticks, midges and others); and invasion of the natural habitat by

[14] 2010, World Conservation Society, 'State of the Wild 2010-2011: A Global Potrait', Island Press.
[15] 2009, Worldwatch Institute, '2009 State of the World: Into A Warming World', W. W. Norton and Company Inc., Washington D. C., U. S. A., accessed 4 Dec. 2009, available at http://www.worldwatch.org/node/5658
[16] 2001, WMO/UNEP Intergovernmental Panel on Climate Change (IPCC), Habiba Gitay, Sandra Brown *et al*, Chapter 5, accessed 12 April 2010, http://www.grida.no/climate/ipcc_tar/wg2/pdf/wg2TARfrontmatter.pdf
[17] 2006, Wilcox B. A., Ellis B., 'Forests and Human Health', FAO, Unasylva No. 224, Vol. 57, 2006/2, http://www.fao.org/docrep/009/a0789e/a0789e03.htm

feral species such as domestic pigs, goats, rats, mice, dogs and cats. These species become pathogen reservoirs particularly in disturbed and fragmented forest adjacent to settlements.

The convergence of human and animal hosts and reservoir and vector species within ecosystems, and the movement, shifting and mixing across the ecosystem continuum affects host–pathogen dynamics in a manner that facilitates disease emergence, as follows:

- pathogens have increased opportunities for host switching (including adaptation to a new host);
- transmission is amplified and the opportunity for more rapid evolution is increased with multiple, interacting transmission cycles;
- pathogens' rate of infection exceeds the threshold required to produce an epidemic or an endemic disease owing to unprecedented population densities of the vector, the reservoir and susceptible human populations;
- pathogens evolve increased pathogenicity, infectivity and ability to avoid immune system detection, owing to increased opportunities for interaction of endemic infection cycles and pathogen strains, and greater density and genetic variability of pathogen populations.

People are eating more seafood, either because it's the most affordable form of protein (as in many poorer nations) or because it's the latest health food trend (as in many wealthy nations).[18] As a result, seafood is shifting from being the last wild ingredient in our diet to being a highly farmed commodity. Farmed seafood, or aquaculture, now provides 42 percent of the world's seafood supply and is on target to exceed half in the next decade. Fish farms are taking up more space on land and at sea, as farmers expand into new streams, bays, and oceans.

Yet even as we depend more on farmed fish, several crises loom that may jeopardize future expansion of this industry. These include a growing scarcity of fish feed and rising concern about the social and ecological fallout from industrial aquaculture. Poorly run fish farms can generate coastal pollution in the form of excess feed and manure, and escaped fish and disease originating on farms can devastate wild fisheries. From salmon farms in Chile to tilapia farms in China, a narrowing base of genetic diversity means that farms will be increasingly susceptible to disease and other stresses, a well-known pattern in agriculture that may play out in aquaculture.

XII. Infectious Diseases Transmission from Vector/Human to Human/Vector:

A change in the ecosystem, in the metereological pattern, global warming, farming practices, diet or food handling can significantly alter the potential that a

[18] Brian Halweil, Worldwatch Institute Report, 'Farming Fish for the Future', ISBN 13: 978-1878071-83-5, available at http://www.worldwatch.org/node/5880

known or unknown pathogen has to cause disease in humans with humans coming in closer or more prolonged contact with carrier species.[19]

Biofilms have great importance for public health because of their role in certain infectious diseases and importance in a variety of device-related infections.[20] Several frank bacterial pathogens have been shown to associate with, and in some cases, actually grow in biofilms, including *Legionella pneumophila, S. aureus, Listeria monocytogenes, Campylobacter spp., E. coli O157:H7, Salmonella typhimurium, Vibrio cholerae*, and *Helicobacter pylori*. Clinical and public health microbiologists' recognition that microbial biofilms are ubiquitous in nature has resulted in the study of a number of infectious disease processes from a biofilm perspective.

Biofilms of potable water distribution systems have the potential to harbor enteric pathogens, *L. pneumophila*, nontuberculous mycobacteria, and possibly *Helicobacter pylori*. What is less clear is an understanding of how interaction and growth of pathogenic organisms in a biofilm result in an infectious disease process. Research should also focus on the role of biofilms in antimicrobial resistance, biofilms as a reservoir for pathogenic organisms, and the role of biofilms in chronic diseases. The key to success may hinge upon a more complete understanding of what makes the biofilm phenotype so different from the planktonic phenotype.

There are three important environmental quality issues associated with the spread of infectious diseases in buildings, all of which are important to building maintenance.[21] The first highlights the importance of maintaining adequate ventilation control. The second relates to nosocomial infections or transmission through contact, either direct contact with infected persons or indirect contact by touching common surfaces such as door knobs, drinking water fountains, phone handles, toilet seats and computer key boards.

The third is the potential for disease vectors (such as rodents, insects, arthropods, birds and fungi) to enter and proliferate in buildings. An unexpected response to the proliferation of pests, especially those that carry diseases that seriously affect human health or the health of plants and animals important to agriculture is the increased use of pesticides and herbicides.

Moisture-related impacts on indoor environment from environmental modification include decomposition of some products, such as plasticizers commonly used in vinyl flooring and adhesives, thus generating byproducts that may be associated with disease/ill-health such as asthma in the case of plasticizer decomposition. Damp and mold conditions in homes are known to be associated with 30-50 per cent increases in respiratory and asthma-related health outcomes.

---

[19] 2009, Shakesphere Martin, 'Zoonoses", Second Edition, Pharmaceutical Press, London, U. K.

[20] Donlan Rodney M., 'Biofilms: Microbial Life on Surfaces' Perspective, Centers for Disease Control and Prevention, Atlanta, Georgia, USA, accessed 4 April 2010, available at http://www.cdc.gov/ncidod/eid/vol8no9/02-0063.htm

[21] 2010, US EPA, 'Public Health Consequences of Climate Change Impacts on Indoor Environment', Mudari David, The Cadmus Group Inc., Arlington, U. S. A.

ANNEX I: BACKGROUND

Bioterrorism is the deliberate release of viruses, bacteria, or other agents used to cause illness or death in people, animals, or plants. Only modest microbiologic skills are needed to produce and effectively use biologic weapons. And biological warfare has afflicted campaigns throughout military history, at times playing an important role in determining their outcomes.

There is a long list of potential pathogens for use by terrorists, but only a few are easy to prepare and disperse. Traditional agents of offensive biowarfare programmes include the causative organisms of anthrax, plague, tularemia, brucellosis, glanders, melioidosis, various foodborne illnesses, cryptosporidiosis, cryptococcosis, Q fever, psittacosis, dengue fever, smallpox, viral equine encephalitides, and the viral hemorrhagic fevers. All are seen in animals, except for smallpox and dengue fever. Of the infectious diseases, the vast majority are zoonoses. The only disease that does not affect animals in Category A is smallpox, which was eliminated by a worldwide vaccination program in the late 1970s. Because these diseases can infect animals and humans, the medical and veterinary communities should work closely together in clinical, public health, and research settings.

Public health, health-care, and veterinary communities have an enormous challenge in the early recognition, reporting, treatment, and prevention of zoonotic diseases. As such, a transformed system of disease surveillance that is predicated on seamless integration of a diverse set of capabilities is required. A truly comprehensive early health-warning system will rely upon the vertical integration of local, state, federal, and international experts, as well as the horizontal integration of animal health, human health, public safety, communication, transportation, intelligence, and national security professionals and institutions.

The U.S. Centers for Disease Control and Prevention (CDC) currently classifies bioterrorism diseases/agents most likely to be used into categories A, B, and C, with A having the highest priority.[22] Of the infectious diseases in CDC's classification system, the majority are zoonoses. Of the Category A diseases, more than 80% are zoonoses. Category C includes emerging diseases, of which about 75% are zoonoses. The majority of biological agents (especially type A) are most effectively used as aerosols. The CDC has already added SARS to the Select Agents List which is currently being reviewed.

To prevent sabotage between private sector industries/organizations, they should be required to report to regulators descriptions of both their existing products, products in their research and development lines, as well as DNA sequences, etc. Bioregulators are biochemicals which control basic human life functions from thought to action and they could be easily weaponized. There is considerable uncertainty about likelihood and magnitude of a bioattack. Development, testing, and evaluation of new disease surveillance methods and technologies to improve clinical recognition and reporting of infectious diseases of concern are urgently needed. Air samplers, installation and lab assays, collection and analysis in designated labs, once every 24 hours of certain pathogens in high risk cities worldwide are necessary.

---

[22] U. S. Centers For Disease Control and Prevention (CDC), Bioterrorism Agents/Diseases, accessed on 19 Aug. 2010, available at CDC | Bioterrorism Agents/Diseases (by Category) | Emergency Preparedness & Response.

ANNEX II: BIODEFENSE PREPAREDNESS FOR EMERGENCY RESPONSE

CBRN Threats and Projected Future Top Priority Medical Countermeasure Programmes of the U.S. Department of Health and Human Services:[23]

TOP PRIORITY CBRN THREATS (LISTED ALPHABETICALLY)	PROJECTED FUTURE TOP PRIORITY MEDICAL COUNTERMEASURE (MCM) PROGRAMS												
	Anthrax antitoxin(s)	Anthrax vaccine	ARS/DEARE MCM(s)	Biodosimetry, Bioassay	Broad spectrum antibiotic(s)	Broad spectrum antiviral(s)	Diagnostics	Enterprise CHEMPACKs	Filovirus MCM(s)	Radionuclide-specific agent(s)	Smallpox antiviral(s)	Smallpox vaccine	Volatile nerve agent single antidote
Bacillus anthracis ANTHRAX; Multi-drug resistant *Bacillus anthracis* MDR ANTHRAX	✦	✦			✦		✦						
Botulinum toxins BOTULISM							✦						
Burkholderia mallei GLANDERS; *Burkholderia pseudomallei* MELIOIDOSIS					✦		✦						
Filoviruses (Ebola and Marburg) HEMORRHAGIC FEVER						✦	✦		✦				
Francisella tularensis TULAREMIA					✦		✦						
Junin virus ARGENTINE HEMORRHAGIC FEVER						✦	✦						
Radiological/nuclear agents			✦	✦						✦			
Rickettsia prowazekii TYPHUS					✦		✦						
Variola virus SMALLPOX						✦	✦				✦	✦	
Volatile nerve agents								✦					✦
Yersinia pestis PLAGUE					✦		✦						

23 2007, U. S. Department of Health and Human Services (DHHS), 'DHHS Public Health Emergency Medical Countermeasure Enterprise Implementation Plan for Chemical, Biological, Radiological, and Nuclear Threats', U.S.A., accessed 27 Aug. 2010, available at http://www.pswrce.uci.edu/pdf/phemce_implplan_041607final.pdf.

About the Expert:

In addition to multidisciplinary university studies in life sciences, biotechnology, hospital administration, environment education, ecotoxicology, and gene ecology, **Ms. Anupa Gupte** (**anupagupte@yahoo.com**) has diverse United Nations work experience relevant to BTWC implementation. Her hospital administration work in India in 1990s included establishing lab biosafety protocols for implementing WHO Guidelines and Standards, managing casualties/emergency medical services, continuing medical education, infection control and antimicrobial resistance.

As an external faculty member of the University of Mumbai (India), she taught 'Principles and Practices of Management' and 'Supervision and Management of Clinical Services' to Registered Nurses of primary health centres in Maharashtra State as part of their graduate studies. Moreover, Anupa contributed to establishing her hospital's systems for patient administration, medical records, computerized lab management, and total quality management for ISO 9000 and 14000 certifications.

Also, she contributed to developing Mumbai city's master plan for emergency preparedness, disaster management, and evacuation and she served as a member of the city's Joint Coordination Committee for mass casualties and emergencies, liaising with the police, forensic investigators, municipal authorities and the Coroner's Court. This experience was useful during her UN field mission in Afghanistan in national environment capacity building for facilitating that Party's compliance with multilateral environment agreements, some of which had border control obligations for preventing illegal trade in environment (biologicals or chemicals).

In collaboration with UNESCO, Anupa included biosafety and biosecurity concepts in developing an environment education approach for Afghanistan that was later used by UNICEF to revise the country's high school curricula. In collaboration with the Germany's Military Police, UN Civilian Police, and Afghanistan's Ministry of Homeland Security, she initiated training of the country's border enforcement officers (police and customs, both civilian and military), and reviewed the National Police Academy's curriculum, recommending a course in biocrime prevention. She provided policy advice and technical inputs to the first drafts of Afghanistan's Customs Law, Environment Protection Act, and Policy Guidelines for Environmental Impacts Assessment.

Moreover, Anupa proposed and contributed to drafting a trilateral agreement of subregional cooperation in border control between Afghanistan, Iran, and Pakistan and she facilitated its endorsement by the three Parties to common multilateral agreements. Subsequently, Anupa prepared separate working draft summaries of multilateral agreements of importance to Iraq, Liberia, and Sudan for initiating UN work in national capacity building in these three Least Developed Countries (LDCs).

Anupa's work in United Nations began in 1998 with facilitating the negotiations of the then draft Cartagena Protocol on Biosafety to the Convention on Biological

Diversity (CBD) wherein she assisted Chairs in Drafting and Contact Groups in building consensus on the treaty text for adoption at plenary sessions. As part of her work in that Secretariat position, she drafted a work plan for establishing and operating the Biosafety Clearing House (BCH) upon adoption and entry into force of the Protocol.

She contributed to conducting a UNDP/UNEP joint needs assessment survey under the UNDP Capacity 21 Initiative for identifying biodiversity and biosafety capacity gaps and needs of Parties. The survey information was later used to develop CBD-enabling activities through international capacity building UNEP/GEF Biosafety Projects under the Cartagena Protocol. Also, she prepared an indicative framework document on global capacity building in biosafety for negotiations of the Conference of the Parties to the CBD that also serves as the Meeting of the Parties to the Protocol. Moreover, Anupa contributed to drafting the Global Taxonomy Initiative, the Global Invasive Species Programme, and to designing the nomination form and selection criteria for establishing the CBD Roster of Experts and she evaluated nominations received from Parties for inclusion in the Roster. She provided policy advice and technical biosafety inputs to drafts of the UN Commission on Science and Technology for Development (UNCSTD).

During that time, she taught global environmental impacts assessment, as a visiting faculty, to final year BSc. Geography students of Concordia University (Canada). In 2005, Anupa completed UNITAR's Instruction Manual for Regional Advisors in Biosafety used by UNEP/GEF Biosafety Projects for online training in biosafety to build regional capacity in Cartagena Protocol implementation. From 2002, Anupa provided policy advice and technical inputs/text for preparing the WHO mega study on modern food biotechnology, human health, and development', presented to the World Health Assembly and published in 2005. Also, she contributed to preparing the WHO/UNEP HELI (Health and Environment Linkages) brochure in 2004 as well as the HELI Synthesis Report, 'Managing the Linkages for Sustainable Development: A Toolkit for Decision Makers' in 2006.

As a founding member of two sister NGOs based in Switzerland, the Health and Climate Foundation (HCF) and Health and Climate Partnerships (HCP), she contributed to writing their website content (about us, who we are, what we do) in 2006 and facilitated their accreditation to the UN CSD (Commission on Sustainable Development). For the WMO in 2006, Anupa planned the organization of a Meeting of Experts on Early Warning Systems. In 2008, she contributed to designing the website content of BINAS (BIosafety Information Network and Advisory Service) that is now being relaunched by UNIDO. Also, she evaluated UNIDO's e-biosafety training course content conducted in collaboration with the University of Gent (Belgium) as part of a Master's degree programme, recommending revisions/updates. She acted as UNIDO's biosafety expert at its Expert Group Meeting on industrial use of plants as biomaterial for bioproduction in a knowledge-based bioeconomy. In 2009, Anupa assisted Co-Chairs of the UNECE Task Force on Persistent Organic Pollutants under the Convention on Long-Range Transboundary Air Pollution in executing their work plan.

In this workshop, Anupa shares her multidisciplinary knowledge and UN expertise about mechanisms for international cooperation on scientific, technical, and technological matters under various BTWC-relevant multilateral agreements.